IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS

ABERYSTWYTH, GREAT BRITAIN

Mimeographed Publication No. 2/1938

CONTENTS

Influence of the interval of time between cuts and of the height of stubble on yield and root development in grasses. A preliminary investigation conducted by the Swedish Grassland Association. By G. Torstensson. (Translated from Swedish).

and

Trials with different times of cutting of meadows at Voll Experiment Station. (Norway). By P. J. Løvø. (Translated from Norwegian).

Translator : Miss R. Peter Jones.

Issued December, 1938.

Price 2s. 6d.

IMPERIAL BUREAU OF PASTURES & FORAGE CROPS
LIBRARY

HERBAGE PUBLICATION SERIES

MIMEOGRAPHED PUBLICATIONS

No.

1/1938. Fourth Session of the Academy of Agricultural Sciences, Moscow, U.S.S.R. December, 1936. (Published January, 1938.)

2/1938. Influence of interval between cuts and of height of stubble on yield and root development in grasses, by G. Torstensson. Translated from Swedish by Miss R. Peter Jones. December, 1938.

3/1938. Collection of full or abridged translations by Miss G. M. Roseveare ; Vernalization, by J. Voss, from German ; Growth in grass species, by N. von Bittera and F. von Gruber, from German ; Potassium on a clover-grass mixture, by M. Zehentner, from German ; Germination of lupins, by J. C. J. Wallebroek, from Dutch ; Poisoning with Sudan grass, by J. Riet and others, from Spanish. December, 1938.

4/1939. Bibliography on red clover (*Trifolium pratense*).

5/1939. Bibliography on white clover (*Trifolium repens*).

6/1939. Bibliography of the published works of V. N. Ljubimenko.

This new series of mimeographed publications will be produced at irregular intervals ; it will be experimental in the first instance, until it is known what demand there is for such a service. The different issues will be devoted to the reproduction of full or abridged translations made by the Bureau staff, either for its own purposes or in reply to specific requests ; also to bibliographies and other information for which space is not available in *Herbage Reviews*.

There will be no free list for these publications ; copies are obtainable at a fixed rate of 2s. 6d. per number. If standing orders are placed for all issues, accounts will be sent at the end of each year, as is the custom with Bulletins. Accounts for individual issues are payable on receipt of publication.

Notice of date of publication of future issues will be sent on request.

IMPERIAL BUREAU OF PASTURES AND FORAGE CROPS,

ABERYSTWYTH, GREAT BRITAIN.

Mimeographed Publication No.2/1938.

Influence of the interval of time between cuts and of the height of stubble on yield and root development in grasses. A preliminary investigation conducted by the Swedish Grassland Association. By G. Torstensson. (Translated from Swedish).

and

Trials with different times of cutting of meadows at Voll Experiment Station. (Norway). By P. J. Iøvø. (Translated from Norwegian).

Translator : R. Peter Jones.

Issued December, 1938. Price 2s. 6d.

IMPERIAL BUREAU OF PASTURES & FORAGE CROPS
LIBRARY
ABERYSTWYTH, GREAT BRITAIN.

TORSTENSSON, G. Skördeintervallens och stubbhöjdens inverkan på avkastning och rotutveckling hos gräs. En hos Svenska Betes- och Vallföreningen utförd förberedande undersökning. [Influence of the interval of time between cuts and of the height of stubble on yield and root development in grasses. A preliminary investigation conducted by the Swedish Grassland Association.] Medd. Svenska Betes- o. Vallfören. No.5. 37. 1938.

Translated from Swedish. (R.P.J.)

Experience shows clearly that too intensive grazing has a detrimental effect on the ley both in regard to the composition of the sward and its continued yielding capacity. This holds good in particular if grazing is so prolonged that the plant stand has no opportunity time after time to grow undisturbed, but it is believed that too hard grazing, that is to say grazing almost down to ground level, also has a harmful effect.

In practice attention has been paid to these problems, and an effort has been made by suitable regulation of the number of animals per unit of area that graze simultaneously and also by division into folds to prevent pastures being too hardly used.

A very common reason for too hard and prolonged grazing is lack of pasture on the whole, due to too small an area, too low a yield per unit of area, or in the worst cases both these causes together.

These problems which are of very great importance for the yield of pastures have been the subject of investigation. In Sweden Borg (1) has sought to estimate the effect of division into folds on the yield of pastures, and Wallin (2) by collating the results from the control farms of the Swedish Grassland Association has investigated the influence of different numbers of animals per unit of area on the yield of the ley.

In Germany, among other workers Münzinger and von Babo (5) have carried out some investigations on this question, and in England Martin Jones (4) in particular has conducted extensive investigations on grazing technique and especially the influence of intensity of grazing on the condition and yield of the ley.

1. Pot experiments with different intervals of time between the cuts and also with different lengths of stubble.

In 1932 under the direction of the writer a series of pot experiments was initiated with different intervals of time between the cuts and with different lengths of stubble, in order

to study the influence of these factors on both size of yield and root development. To be able to keep the other factors as constant as possible, similar for all the experiment moments, these investigations were carried out as pot experiments. The material used consisted of pure stands of grasses.

This series of experiments was more particularly intended as a preparatory investigation and it was for that reason carried out as simply as possible. Thus the number of replications was generally only four, and sometimes the green mass was determined in the continuous cuts only from one pot in each series, while the total yield of dry matter was ascertained for all the pots.

That the material in spite of this incompleteness is now presented is due to the fact that the writer, owing to altered conditions of work, was unable, as was originally intended, to carry on and extend the investigation, and also that the results obtained are confirmed by similar investigations carried out elsewhere, whereby their value is considerably enhanced.

During the year 1932 the investigation in question was conducted with Italian ryegrass which was sown in liberally manured soil mixed with crushed quartz in ordinary so-called Mitscherlich pots.

The experiment comprised the following moments:

Moment I. 5 cm. stubble, cut every 15th day
" II. 5 " " " " 10th "
" IV.* 2 " " " " 10th "

The experiment rendered possible therefore a comparison of cuts taken with varying frequency with the same length of stubble (5 cm.), as well as of the influence of different lengths of stubble when cutting was carried out every tenth day.

The experiment was sown on May 21 and on June 28 the stand was cut down leaving the above-mentioned lengths of stubble. The harvested mass obtained in this way is not included in the results of the experiments.

The yield of green mass in the different moments is shown in Table 1 and Diagram 1 (orig. publ.).

Table 1. Average yield (grm.) of green mass for the different moments.

Cut on	Moment		
	I	II	IV
8/7	-	32.0	37.0
12/7	57.6	-	-
18/7	-	57.6	55.2
26/7	69.8	40.9	34.3
6/8	-	18.8	19.8
11/8	30.5	-	-
19/8	-	9.3	9.7
21/9	9.8	3.5	3.3
Total	167.7	162.1	159.3

* This symbol was selected in analogy with the experiments during other years.

The average yield of dry matter was for:

Moment I. 30.8 ± 1.3*
" II. 24.8 ± 0.6
" IV. 21.3 ± 1.0

The difference between moments I and II and between moments II and IV is certain. This applies in particular to the first-mentioned difference (D/m 4.3), and the length of the interval of time between the different cuts has thus, in this experiment, been clearly decisive. But the length of the stubble has also affected the yield, and the difference between the yield with respectively 5 cm. and 2 cm. stubble and ten days interval between the cuts was statistically certain (D/m 3.0).

Following the last cut, the root mass, after it had been washed and dried, was weighed in the air-dried condition. As the roots from three pots only in each moment were dealt with, distribution could not be computed, and therefore the weights from all the pots examined are given here.

Air-dry root mass in grm.

Moment		
I	II	IV
37.8	33.5	12.4
64.5	49.0	10.2
64.4	55.7	9.9
Average 55.6	46.1	10.8

* Calculated according to the formula $\sqrt{\frac{\Sigma d2}{n(n-1)}}$.

Concerning root development also an interval of fifteen days between the cuts was thus superior to one of ten days. It is, however, most noteworthy that the length of stubble had so marked an effect on root formation. While 5 cm. stubble with regard to harvested yield was only just so much superior to 2 cm. stubble that the difference can be considered to be statistically assured, the root mass in the former case was four times as great as in the latter.

To investigate more closely the influence of stubble length on root development the experiment was extended during the following year to include stubble lengths of 5 and 2 cm. with intervals of 10 days and 15 days between the cuts. Further, the experiment was carried out with Italian ryegrass and meadow fescue.

Green weight was determined only for one pot per series, while dry matter was determined for all the pots.

By this method of procedure of course the growth curves for the different moments were very uncertainly determined, but as they constitute an interesting addition to the other data they are shown in Diagrams 2 and 3 and the results are also presented in Table 2. The particulars were as follows:

Moment	I.	5	cm.	stubble,	cut	every	15th	day
"	II.	5	"	"	"	"	10th	"
"	III.	2	"	"	"	"	15th	"
"	IV.	2	"	"	"	"	10th	"

Table 2. Green mass (grm.) for the different moments

Cut on	Ser. 1. Italian ryegrass				Ser. 2. Meadow fescue			
	Moment				Moment			
	I	II	III	IV	I	II	III	IV
13/6	2.45	3.40	7.60	7.90	-	-	-	-
22/6	-	16.60	-	24.50	4.65	3.10	12.55	12.90
28/6	68.50	-	83.75	-	-	-	-	-
3/7	-	77.80	-	79.15	-	29.80	-	35.15
8/7	-	-	-	-	71.30	-	59.40	-
13/7	98.50	69.30	95.5	69.90	-	56.75	-	42.55
23/7	-	27.80	-	33.10	81.10	48.60	81.90	28.10
28/7	55.25	-	53.35	-	-	-	-	-
2/8	-	11.50	-	16.00	-	21.10	-	15.60
7/8	-	-	-	-	25.20	-	29.50	-
12/8	11.00	6.50	8.00	4.00	-	11.50	-	13.00
22/8	-	8.40	-	10.65	14.05	7.52	18.65	11.45
28/8	15.65	-	16.15	-	-	-	-	-
1/9	-	8.45	-	7.60	-	6.15	-	5.75
6/9	-	-	-	-	8.45	-	8.30	-
11/9	5.95	2.75	5.90	1.20	-	1.60	-	1.25
21/9	-	1.25	-	0.75	1.65	0.75	1.45	0.55
Total	257.30	233.75	270.25	254.75	206.40	186.87	211.75	166.30

The yield of dry matter in the two series was:

	Moment			
	I.	II.	III.	IV.
Italian ryegrass	40.2 ± 0.6	35.9 ± 0.4	40.7 ± 0.2	33.6 ± 0.5
Meadow fescue	36.6 ± 0.6	31.2 ± 0.0	35.7 ± 0.3	26.1 ± 0.7

In this experiment also the interval between the cuts had a decisive effect on harvested yield. Thus an interval of 15 days between the cuts for both grasses gave a certain increased yield whether cutting was carried out with 5 cm. or 2 cm. stubble, while stubble length gave a significant result only with reference to an interval of 10 days in meadow fescue.

The weight of the root mass in the air-dried condition is shown by the following statement:

Air-dry root mass in grm.

	Moment I.	II.	III.	IV.
Italian ryegrass A.	67.0 ± 11.2	51.6 ± 6.9	43.5 ± 3.1	23.5 ± 2.5
Meadow fescue B.	31.5 ± 4.4	27.5 ± 3.0	21.5 ± 0.8	13.0 ± 1.6

The root weights show great variation and the differences between moments I and II are not certain either for ryegrass or meadow fescue. Whether the two grasses were cut every 15th or every 10th day has therefore with a stubble length of 5 cm. not with certainty influenced root development. With 2 cm. stubble the case is quite different; then the time between the cuts exerts a great influence on the development of the root mass. The difference with 15 day and 10 day intervals respectively, is then highly significant, or 20.0 ± 4.0 for Italian ryegrass and 8.5 ± 1.8 for meadow fescue. The certainty of the difference is in the two cases D/m 5.0 and 4.7 respectively.

If finally we group the material together with regard to stubble length for the different intervals the following results are obtained:

	Moment	Difference	D/m
Italian ryegrass	I - III.	23.5 ± 11.6	2.0
	II - IV.	28.1 ± 7.3	3.9
Meadow fescue	I - III.	10.0 ± 4.5	2.3
	II - IV.	14.5 ± 3.4	4.3

Both Italian ryegrass and meadow fescue have in this experiment proved relatively insensible to short stubble length with 15 days interval between the cuts. If the interval of time be reduced to ten days the lower stubble gives considerably less root mass. This applies to the two grasses investigated and the difference is certain in both cases.

During the year 1934 the experiment was repeated according to the same plan as in the preceding year, but included meadow fescue only.

The green weight was determined only for one pot, while the amount of dry matter was ascertained for all.

The 4 moments comprised:

Moment	I.	5	cm.	stubble	length,	cut	every	15th day
"	II.	5	"	"	"	"	"	10th "
"	III.	2	"	"	"	"	"	15th "
"	IV.	2	"	"	"	"	"	10th "

The yield of green mass is shown by Table 3 and Diagram 4.

The yield of dry matter was on the average per pot:

	Moment			
	I.	II.	III.	IV.
Meadow fescue	40.6 ± 0.5	35.3 ± 0.4	40.1 ± 0.4	32.6 ± 0.3

In this experiment also the time between the different cuts was decisive for the harvested yield in that 15 days interval gave the same yield whether cutting was carried out with a stubble length of 5 or 2 cm. There is a small difference in the case of the 10 days interval and its certainty is D/m 5.4.

Table 3. Green mass (grm.) for the different moments.

Cut on	Moment			
	I	II	III	IV
25/6	1.9	1.8	8.2	5.6
5/7	-	29.0	-	29.8
10/7	52.7	-	61.0	-
15/7	-	49.3	-	43.6
25/7	58.9	47.9	63.5	38.2
4/8	-	37.7	-	30.2
9/8	54.6	-	55.4	-
14/8	-	16.5	-	21.5
24/8	12.6	6.2	13.2	8.7
3/9	-	3.8	-	4.3
13/9	20.3*	8.9	22.7*	12.0
24/9	9.0	8.0	9.4	10.3
4/10	-	2.8	-	5.0
8/10	4.3	-	4.7	-
15/10	-	2.6	-	1.6
27/10	2.4	-	3.1	-
Total	216.7	214.5	241.2	210.8

The root mass in this experiment in the air-dried condition (15 per cent moisture) amounted to:

Moment			
I.	II.	III.	IV.
32.8 ± 2.4	17.9 ± 1.9	17.3 ± 1.6	3.9 ± 2.0

The results for both the time between the cuts and the length of stubble were in this experiment very highly significant. Thus the difference between the 15 and 10 day intervals was:

With 5 cm. stubble	14.9 ± 3.1	D/m 4.8
" 2 " "	13.4 ± 2.6	" 5.2

*Owing to an oversight cut on 13/9 instead of on 8/9.

The 10 days interval has therefore both with 5 and 2 cm. stubble length given less root mass than the 15 days interval and the difference was significant.

The influence of length of stubble on root mass is shown by the following statement:

With 15 days interval the difference in root mass between 5 and 2 cm. stubble was

$$15.3 \pm 2.9 \quad D/m\ 5.3$$

With 10 days interval the difference in root mass between 5 and 2 cm. stubble was

$$14.0 \pm 2.7 \quad D/m\ 5.2$$

Thus the length of stubble also has had a pronounced effect on root mass, and in this case too the differences were quite certain.

During the year 1935 the experiment with meadow fescue was carried out according to the same plan as before. The green mass was determined at each cut for all the pots. (See Diagram 5 and Table 4).

Through an oversight the dry matter content was not determined in the material from this experiment, so that only the hay weight is available. This was in grm. per pot:

Moment

I.	II.	III.	IV.
40.1 ± 0.64	36.1 ± 1.44	40.3 ± 0.26	33.0 ± 1.42

Table 4. Green mass (grm.) for the different moments.

Cut on	Moment			
	I	II	III	V
25/6	5.98	7.13	10.23	8.58
6/7	-	37.40	-	43.68
10/7	60.90	-	69.38	-
15/7	-	38.68	-	38.70
25/7	52.83	26.95	55.55	30.43
5/8	-	21.45	-	22.55
9/8	36.63	-	38.48	-
14/8	-	28.90	-	27.48
24/8	32.40	18.08	37.55	17.50
3/9	-	7.48	-	7.70
13/9	14.40	3.20	13.28	2.10
25/9	4.00	2.40	3.58	2.00
3/10	-	0.50	-	1.35
8/10	0.68	-	0.53	-
13/10	-	0.88	-	0.50
18/10	1.15	-	0.43	-
Total	208.97	193.05	229.01	202.57

Thus the results agree with those reported previously in that in this case also the time between the cuts was decisive for the size of the harvested yield. In comparison therewith stubble length played a subordinate part as far as harvested yield is concerned.

Also with reference to development of root mass, agreemen with investigations during the preceding years is very good.

The weight of the root mass in this experiment was:

Moment			
I.	II.	III.	IV.
38.6 ± 1.2	28.8 ± 1.2	25.4 ± 0.5	16.7 ± 0.8

The difference for the length of the interval between the cuts was as follows:

Cutting every 15th day gave an increased yield compared with cutting every 10th day

with 5 cm. stubble length of 9.8 ± 1.7 D/m 5.8
" 2 " " " " 8.7 ± 0.9 " 9.7

and was therefore in both cases quite considerable and determined with certainty.

The same applies to the influence of length of stubble, which was as follows:

Cutting with 5 cm. stubble length gave a greater yield than cutting with 2 cm. stubble length:

with 15 days interval of 13.2 ± 1.3 D/m 10.1 and
" 10 " " " 12.1 ± 1.4 " 8.6

Unfortunately the material does not permit of a direct comparison between the different years. Thus Italian rye grass was included in the experiments during the first two years, 1932 and 1933, but the 1932 experiment comprised only moments I, II and IV. In 1933 and subsequently meadow fescue was the experimental plant, when all 4 moments were the subject of investigation, but as stated above for 1935 figures for hay only were available, while during the other years the yield of dry matter was determined.

Owing to this lack of uniformity in the carrying out of the experiments during the different years a direct comparison from year to year is not possible, but an examination of the position of the various moments during the different years gives very interesting results.

In the 1932 experiment, in which moment III was not included, the order was: I, II and IV. During the other years the order was I, III, II and IV, when, however, it is to be noted that moments I and III in the 1933 experiment with Italian ryegrass gave practically the same result.

Table 5. Root value for the different moments.

	Moment	Harvested yield	Root mass	Root value
Italian ryegrass 1932	I	30.8	55.6	0.55
	II	24.8	46.1	0.54
	IV	21.3	10.8	1.97
Italian ryegrass 1933	I	40.2	67.0	0.60
	II	35.9	51.6	0.70
	III	40.7	43.5	0.94
	IV	33.6	23.5	1.43
Meadow fescue 1933	I	36.6	31.5	1.16
	II	31.2	27.5	1.13
	III	35.7	21.5	1.66
	IV	26.1	13.0	2.01
Meadow fescue 1934	I	40.6	32.8	1.24
	II	35.3	17.9	1.97
	III	40.1	17.3	2.32
	IV	32.6	3.9	8.36
Meadow fescue 1935	I	40.1	38.6	1.04
	II	36.5	28.8	1.27
	III	40.0	25.4	1.57
	IV	33.0	16.7	1.98

The experiments thus showed jointly that 15 days interval between the cuts and 5 cm. stubble length gave the highest yield, followed closely by 15 days interval and a stubble length of 2 cm. Next came 5 cm. stubble length and 10 days interval, and 10 days

interval with 2 cm. stubble length gave the poorest yield.

If a similar examination of the root mass in the different moments be carried out, we make the interesting observation that root development in the various moments is influenced in a different way from green mass, in that stubble length had a greater effect on root development than on leaf mass. The order for root mass was namely throughout I, II, III and IV. The combination 5 cm. stubble length and 10 days interval gave therefore a larger root mass than 2 cm. stubble length and 15 days interval, thus the converse to what was the case as regards harvested yield.

The predominating influence of stubble length on root development is also shown by calculation of the root value (Harvested yield/Root mass) for the different moments. (Table 5.) With but trifling exceptions the root value rises from moment I → IV which with the experimental arrangement employed signifies that stubble length has had a greater influence on root development than the length of the interval between the cuts.

2. Plot experiment with different lengths of stubble.

In the spring of 1933, to supplement the pot experiment, a plot experiment was laid down on the experimental grounds of the Swedish Grassland Association. This included the species meadow fescue, smooth-stalked meadow-grass, timothy and perennial ryegrass. These species were sown in pure plots with a distance between the

drills of 10 cm. on 2 × 10 m. plots with 5 replications.

The experiment was designed to test the effect of stubble length on the yield and root development of the grasses. As soon as the stand had made the necessary growth it was cut with an ordinary hand-mowing machine. In doing this the plots were divided in the longitudinal direction into two halves, one of which was cut with a stubble length of 7 cm. and the other with one of 3 cm. It had been intended to use the same stubble lengths as in the pot experiment, but it was impossible to obtain a shorter stubble length than 3 cm. with the mower employed. To obtain a sufficiently striking difference between the two moments the other stubble length was 7 cm.

Clipping was repeated as soon as the aftergrowth permitted, which caused the intervals of time between the different clippings to vary greatly according to the intensity of growth during the course of the summer, but both moments, the one with 7 and the one with 3 cm. stubble, were always cut at the same time. The interval of time between the cuts was therefore in the experiment under consideration the same, and only the stubble length varied.

The trial was carried out according to the principle indicated during the summers 1933-1935 and after the four grass species had been treated in this way during those years the stand was allowed to grow undisturbed in the summer of 1936; cutting was carried out on June 19 with the same stubble length

for both moments. This arrangement of the experiment was selected to see whether the preceding years' cutting of grasses with varying stubble length occasioned such a change in the development of the grasses that this perchance would be reflected in the harvested yield.

The yield for the two stubble lengths in kg. dry matter per 8 sq. m. harvested plot was:

	After 7 cm. stubble	After 3 cm. stubble	Difference
Meadow fescue	2.08 ± 0.05	1.89 ± 0.16	0.19 ± 0.17
Smooth-stalked meadow grass	1.58 ± 0.12	1.28 ± 0.13	0.30 ± 0.18
Timothy	2.18 ± 0.20	1.83 ± 0.14	0.35 ± 0.24
Perennial ryegrass	1.10 ± 0.08	0.79 ± 0.10	0.31 ± 0.13

As is seen the moment which during the preceding years was cut with 7 cm. stubble has throughout given a slightly higher yield than the moment with 3 cm. stubble, but the difference is insignificant and in no case statistically certain.

In these field trials also the effect of stubble length on the development of the root system was investigated. For this purpose a soil sample was taken immediately after cutting. Apparatus constructed by the author for such investigations was used. This consisted of an edged rectangular steel frame 30 cm. high with an area of 20 × 30 cm.

The frame was driven into the ground by means of a hammer

and delimited below. Subsequently a loose bottom was placed in the frame by means of which through a screw arrangement the column of soil could be forced out.

The sward itself was cut off to a depth of 2 cm., after which the column of soil was divided into horizontal layers of 5 cm.

The root mass from each layer was washed free from soil and dried at 110°C. to a constant weight.

Concerning the utility of the method for the investigation in question, one of the author's co-workers who was responsible for this special branch stated that at first certain difficulties were encountered. Thus the soil, a light to medium clay mixed with sand, was so dry when samples were taken in June, that only after liberal watering was it possible to drive the steel frame into the ground to the appointed depth. Sometimes large stones necessitated the taking of further samples, and occasionally the column of soil was not sufficiently consolidated to permit of division of the sample into horizons, which also necessitated the taking of additional samples. He reported too some other difficulties, but his final verdict is that "the method was simple and rendered rapid sample taking possible. It furnished sufficient accuracy for the determination of the upper horizons with their relatively large

differences, but in the lower horizons, where the root mass consisted of fine hairs without mutual cohesion, the differences were possibly too small to be shown exactly." He states further that with the relatively small area of ground which the frame delimited, the variations between the parallel samples were sometimes quite considerable owing to inequalities of the stand.

As the stand of perennial ryegrass was very uneven it was excluded from this investigation.

In sampling three frame samples were taken in each half of the plot, thus from 7 and 5 cm. stubble respectively, with the places where the samples were taken opposite one another each on its own side of the boundary between the halves of the plots.

In Table 6 and Diagram 6 the results of this investigation are brought together. The so-called sward has not been included. Further it should be noted that the three samples from the several horizons are compared horizon-wise.

As is seen the material is very uneven and therefore of little reliability, but it indicates that there is a distinct suggestion that root development has been favoured by long stubble. Thus the averages for the three grasses in the moments investigated with few exceptions are higher for 7 cm. than for 5 cm. stubble length. The sparse material, however, does not permit of any computation of its certainty.

Table 6. Root mass, grm. dry matter.

	Cut with 7 cm. length of stubble					Cut with 3 cm. length of stubble				
	Horizon					Horizon				
	1	2	3	4	5	1	2	3	4	5
	grm.	grm.	grm.	grm.	grm.	grm.	grm.	grm.	grm.	grm.
Meadow fescue	5.35	3.70	2.54	1.85	1.76	3.20	3.43	2.35	1.33	0.81
	7.36	1.81	1.52	-	1.53	4.50	5.16	2.95	3.40	1.46
	12.00	7.50	4.38	-	0.55	8.65	4.15	2.43	1.50	1.36
Average	8.24	4.34	2.81	1.85	1.28	5.45	4.25	2.57	2.08	1.21
Smooth-stalked meadow grass	19.61	3.78	2.10	-	-	12.48	2.88	1.37	0.31	0.20
	20.18	3.08	1.00	1.59	0.63	5.16	2.57	0.85	0.28	0.07
	18.19	4.31	0.87	0.76	0.23	13.26	3.47	1.00	0.51	0.51
Average	19.33	3.72	1.32	1.18	0.43	10.30	2.97	1.07	0.37	0.26
Timothy	7.80	1.58	-	0.34	0.20	1.84	1.44	-	0.68	0.38
	2.18	2.47	0.74	0.67	-	5.17	1.96	1.25	-	0.85
	4.30	2.17	1.10	0.75	1.09	-	2.12	1.63	0.81	0.53
Average	4.76	2.07	0.92	0.59	0.64	3.50	1.84	1.44	0.74	0.59

It is remarkable how large a part of the total root mass is found in the uppermost 5 cm. This applies particularly to smooth-stalked meadow grass, while meadow fescue is deeper rooted.

3. Pot trials with different "grazing periods" and resting periods.

In 1933 and subsequently a new series was included in the present investigation; this was arranged to correspond as closely as possible to changes between grazing periods and resting

periods in pasturing. The experiment was conducted as reported previously in ordinary Mitscherlich pots and the height of stubbl at full "grazing" in all moments was 2 cm. The experiment comprised the following moments:

Moment I rapid grazing, ordinary resting period
" II slow grazing, ordinary resting period
" III slow grazing, short resting period
" IV medium-long grazing, ordinary resting period.

In rapid grazing, the whole stand was cut down at once to a 2 cm. stubble, while in slow and medium-long grazing respectively cutting was carried out in succession so that, for example, with a 7-day grazing period a 2 cm. stubble length is reached on the seventh day.

The accompanying table gives particulars of the times of cutting and undisturbed rest respectively in the different moments.

Moment	Number of days for									
	cut-ting	after-growth	cut-ting	after-growth	cut-ting	after-growth	cut-ting	after-growth	cut-ting	after growt
I	1	14	1	20	1	29	1	29	1	29 an so o
II	7	8	10	11	16	14	16	14	16	
III	4	3	5	6	7	8	7	8	7	8 an so o
IV	4	11	4	17	7	23	7	23		

The experiment was carried out with Italian ryegrass and during 1933 the yield of dry matter calculated for the different moments was:

Moment I	Moment II	Moment III	Moment IV
42.3 ± 0.3	31.5 ± 0.2	27.0 ± 0.4	33.9 ± 0.9

Moment I with rapid "grazing" and ordinary resting period gave therefore the best yield, followed by Moment IV, medium-long "grazing period" and ordinary resting period. Moment III, slow "grazing" and short resting period, gave the poorest yield, while Moment II, slow "grazing", ordinary resting period occupied an intermediate position.

In this series also the root mass was washed. In the air-dried condition its weight on the average for the different moments was:

Moment I	Moment II	Moment III	Moment IV
35.9 ± 2.4	33.5 ± 3.6	23.7 ± 3.4	26.2 ± 1.8

As regards root mass also Moment I came first, and Moment III here as with reference to harvested yield gave the poorest result. For the two other moments on the contrary the order was reversed.

The following year, 1934, a new experiment was sown and the yield of this, reckoned as dry matter for the different moments, was:

Moment I	Moment II	Moment III	Moment IV
53.3 ± 0.8	39.9 ± 0.3	32.8 ± 0.6	45.2 ± 0.5

As is seen in this experiment too Moment I, rapid "grazing" with ordinary resting period has given the highest yield. The harvested yield decreased for the different moments, as in the previous year's experiment, with increased cutting time and reduced resting period.

The root weights from this experiment were remarkable inasmuch as they showed exceptionally large variations. The root weight in the air-dried condition (15 per cent water) was:

Moment			
I	II	III	IV
50.0 ± 7.8	10.6 ± 2.1	1.6 ± 0.8	32.5 ± 4.8

The sequence for the different moments was the same for root weight as for harvested mass. Also in this case Moment I was first, followed by Moments IV, II and III in the order mentioned, but the difference between the moments was extraordinarily large and the poor root development in Moments II and III is particularly noteworthy.

In 1935 also the experiment was carried out with Italian ryegrass. Through an oversight the content of dry matter was not determined that year but the hay yield was as follows:

Moment			
I	II	III	IV
60.9 ± 0.5	38.0 ± 2.4	34.1 ± 0.5	47.7 ± 0.8

Broadly speaking the results are the same as those of the two preceding years. In this case too the sequence of the moments was I, IV, II and III and the root weight shows the same proportion.

The root weight in the air-dried condition was:

Moment			
I	II	III	IV
48.2 ± 1.6	29.3 ± 1.4	19.5 ± 0.8	40.3 ± 1.9

An examination of the certainty of the yield difference during the different years gives the following result, in which the differences are calculated for the different moments according to their order of precedence during the different years

The superiority of Moment I, rapid "grazing" and ordinary resting period as compared with Moment IV is therefore determined with very great certainty. The certainty of the other differences varies as is shown by Table 8.

Table 8. The difference in harvested yield between the different moments grouped according to the position they occupied with respect to yield during the various experiment years.

	Moment	Difference	D/m
1933	I-IV	8.4 ± 0.9	9.3
	IV-II	2.4 ± 0.9	2.7
	II-III	4.5 ± 0.4	1.1
1934	I-IV	8.1 ± 0.9	9.0
	IV-II	5.3 ± 0.6	0.9
	II-III	7.1 ± 0.7	10.1
1935	I-IV	13.2 ± 0.9	14.7
	IV-II	9.7 ± 2.5	3.9
	II-III	3.9 ± 2.5	1.6

The investigation permits therefore of the conclusion that under the prevailing conditions the yield was greatest with "rapid grazing and ordinary resting period" and that it declined in the same proportion as the grazing time increased and the resting period decreased.

Root development too, with one exception, showed the same tendency as harvested yield. Thus the order of precedence among the different moments, with the previously mentioned exception, was the same for root mass as for harvested yield and the size of the differences was of the same order of magnitude. In Table 9 the differences and their certainty are cited, and from this comparison it is evident that the differences in root mass in the 1933 year experiment were not certain, neither was the difference between Moment I-IV in 1934.

Table 9. The difference in root mass between the different moments grouped according to the position they occupied with respect to root development during the various experiment years.

	Moment	Difference	D/m
1933	I-II	2.4 ± 4.3	0.6
	II-IV	7.3 ± 4.0	1.8
	IV-III	2.5 ± 3.9	0.6
1934	I-IV	17.6 ± 9.2	1.9
	IV-II	21.9 ± 5.2	4.2
	II-III	9.0 ± 2.3	3.9
1935	I-IV	7.9 ± 2.5	3.2
	IV-II	11.0 ± 2.4	4.6
	II-III	9.8 ± 1.6	6.1

4. Plot trials with different grazing and resting periods.

Simultaneously with pure plot trials reported on previously in which cutting of the grasses with different length of stubble was carried out, a plot trial was also initiated as a parallel to the pot trial with different "grazing and resting periods". This too was set up on the experimental grounds of the Swedish Grassland Association in the immediate vicinity of the Institution.

The plan of the trial was exactly the same as that followed in the pot trial series and included therefore the following moments:

Moment I. Rapid grazing, ordinary resting period.
" II. Slow grazing, ordinary resting period
" III. Slow grazing, short resting period
" IV. Medium-long grazing, ordinary resting period.

Cutting was carried out by means of a grass clipping machine when the growth of the plant stand permitted, otherwise the sickle was used; the stand consisted of a pasture ley sown in 1931. The size of plot was 1 × 5 m. and the trial was conducted with four replications.

In the first year of the trial, 1933, the total yield was reckoned as dry matter:

Moment			
I	II	III	IV
136.5 ± 10.7	61,5 ± 3.0	45.6 ± 1.1	103.6 ± 1.4

The order of precedence of the different moments was therefore I, IV, II and III, thus the same as in the corresponding pot trial series. This was also the case in the two subsequent years, when the yield in dry matter was:

	Moment			
	I	II	III	IV
1934	106.0 ± 6.4	40.3 ± 0.6	35.2 ± 1.1	80.0 ± 1.8
1935	190.0 ± 7.4	52.1 ± 2.4	37.0 ± 0.9	60.2 ± 1.3

In the three years therefore "rapid grazing, ordinary resting period" gave the highest yield and the yield fell in the same proportion as the cutting period was increased and the resting period reduced.

Table 10. The difference in harvested yield between the different moments according to the position they occupied during the various experiment years.

Year	Moment	Difference	D/m
1933	I-IV	22.9 ± 10.7	2.1
	IV-II	42.1 ± 3.2	13.2
	II-III	15.9 ± 3.2	5.0
1934	I-IV	26.4 ± 6.6	4.0
	IV-II	39.7 ± 1.9	20.9
	II-III	5.1 ± 1.3	3.9
1935	I-IV	130.6 ± 7.4	17.6
	IV-II	8.1 ± 2.7	3.0
	II-III	15.1 ± 2.6	5.8

The yield varied markedly during the different years, and the difference between the moments varied greatly from year to year. This is seen from Table 10 which also gives the certainty of the differences.

Although the yield figures for the first two years differ considerably from each other, yet the differences between the different moments are very small during those two years. The 1935 year trial presents on the other hand a very different picture with the largest differences between Moments I and IV and the smallest between IV and II. All the differences are statistically certain.

As in the plot trial with different lengths of stubble reported on previously, in this trial also the effect of the different treatments on harvested yield and root development was investigated. After the trial had been in progress for three years and the different moments in this way during that period ha been uniformly "prepared" all the moments were allowed to grow undisturbed during 1936; they were cut on June 22. The net plo were 4 sq. m. The harvested yield was in dry matter:

Moment			
I	II	III	IV
109.0 ± 5.3	113.0 ± 3.5	103.0 ± 4.4	107.0 ± 7.7

Moment II thus gave the highest yield and Moment III the lowest, but the differences were throughout inconsiderable and in no case statistically certain.

The investigation indicated therefore that with the experimental technique employed by the author, the different treatment in the three preceding years of the various moments had not been able to affect the stand in such a degree that this was reflected in the next year's development or yield.

As in the plot trial with different lengths of stubble reported on previously, so in this trial the root weight in the different moments was determined. The method of procedure was the same as that already described. In this trial too soil samples were taken with the apparatus referred to above; the samples were divided into 5 cm. horizons. After the root mass had been washed free from soil, it was dried at 110°C. to a constant weight. The results of the root investigation are giv in Table 11.

Root development was therefore remarkably uniform in the different moments. The uppermost 5 cm. horizon showed throughout a considerably larger root mass than the following horizons, but the variations between the different moments were inconsiderable and lay within the limits of error for such an investigation.

Table 11. Root mass, grm. dry matter.

	Horizon				
	I	2	3	4	5
	grm.	grm.	grm.	grm.	grm.
Moment I	7.88	1.50	1.03	0.71	0.26
	6.37	3.00	1.06	1.00	0.57
	7.71	2.08	0.35	0.33	0.39
Average	7.32	2.19	0.81	0.68	0.41
Moment II	8.35	2.97	-	-	0.44
	8.94	2.35	1.58	1.16	0.62
	5.24	1.90	0.72	0.86	0.58
Average	7.51	2.41	1.15	1.01	0.55
Moment III	6.75	2.31	1.33	0.43	0.26
	5.52	-	0.45	0.10	-
	8.08	1.84	0.44	0.44	0.18
Average	6.78	2.08	0.74	0.32	0.22
Moment IV	8.88	1.85	1.72	-	0.49
	8.35	2.36	1.51	0.26	0.36
	5.79	1.81	1.00	0.36	0.14
Average	7.67	2.01	1.41	0.31	0.33

The measures adopted in this trial during three years in succession for different "grazing and resting periods" had therefore not affected the root system of the plant stand to an extent worth mentioning.

In explanation of the fact that the pot trial series and the plot trial series thus gave different results in regard

Table 11. Root mass, grm. dry matter.

	Horizon				
	I	2	3	4	5
	grm.	grm.	grm.	grm.	grm.
Moment I	7.88	1.50	1.03	0.71	0.26
	6.37	3.00	1.06	1.00	0.57
	7.71	2.08	0.35	0.33	0.39
Average	7.32	2.19	0.81	0.68	0.41
Moment II	8.35	2.97	-	-	0.44
	8.94	2.35	1.58	1.16	0.62
	5.24	1.90	0.72	0.86	0.58
Average	7.51	2.41	1.15	1.01	0.55
Moment III	6.75	2.31	1.33	0.43	0.26
	5.52	-	0.45	0.10	-
	8.08	1.84	0.44	0.44	0.18
Average	6.78	2.08	0.74	0.32	0.22
Moment IV	8.88	1.85	1.72	-	0.49
	8.35	2.36	1.51	0.26	0.36
	5.79	1.81	1.00	0.36	0.14
Average	7.67	2.01	1.41	0.31	0.33

The measures adopted in this trial during three years in succession for different "grazing and resting periods" had therefore not affected the root system of the plant stand to an extent worth mentioning.

In explanation of the fact that the pot trial series and the plot trial series thus gave different results in regard

to the influence of the different moments on root development, it must be stated that the pot trials were of one year's duratic the stand being subjected from the beginning to the different measures in question, while the plot trials were not begun until the ley was in its third year. Further the schedule for the different "grazing periods" could be accurately adhered to in th pot trials with their continuous luxuriant growth, while the plo trials during the dry period showed such poor aftergrowth that, although the schedule was followed, the different grazings were sometimes illusory.

5. Other investigations concerning the influence of intensity of cutting and of length of stubble on the yield and root development of grasses.

As already emphasized the author's own results have been verified by similar investigations conducted abroad during recent years. Thus Sprague cites the following results from an investigation in a plot stand carried out at New Jersey Agricultural Experiment Station, U.S.A.

Thus cutting was carried out the same number of times in both moments and it was only the length of stubble which vari Its influence varied considerably, as is seen from the table.

Table 12. Root weight and harvested yield in pounds per 1000 sq. ft. 1931.

	Cut twice a week length of stubble .25"			Cut twice a week length of stubble .875"		
	root weight from horizon 1-9" when cut 23/6/1931	harvested yield during period April-1 July	root weight/ harvested yield	root weight from horizon 1-9" when cut 23/6/1931	harvested yield during period April-1 July	root weight/ harvested yield
Agrostis tenuis....	23.1	26.5	1/0.87	35.7	27.4	1/1.30
Agrostis canina....	29.5	26.9	1/1.10	37.1	25.3	1/1.47
Agrostis palustris.	24.5	28.7	1/0.85	42.2	14.3	1/2.95
Festuca duriuscula	50.0	66.7	1/0.75	58.7	27.2	1/2.16

Thus the harvested yield was only slightly affected whether the cutting of Agrostis tenuis and A. canina was carried out with .25 in. or .875 in. stubble, while the shorter stubble entailed a very considerable reduction in yield in the other two species. Root development on the contrary was influenced more uniformly, but the deterioration in root development caused by the short stubble was most marked in Agrostis palustris and least in Festuca duriuscula. The ratio root weight : harvested yield was throughout lower in the moment with .25 in. stubble than with .875 in. stubble length.

Sprague's compatriot Gernert has published the results of an investigation with different numbers of cuts conducted at Oklahoma Agricultural Experiment Station, U.S.A. This investigation also was carried out in the field and included a number of different species in a mixed stand. It was in progress for six years. As the species constituting the stand do not occur in Sweden, only an excerpt from Gernert's work will be given (Table 13).

Table 13. Harvested yield and root development with varying numbers of cuts of grass plots.

No. of cuts per year	Tons hay per acre	Root weight in grm. per cylinder
2	1.02	11.2
3	1.36	10.0
5	1.22	13.4
8	0.82	5.9
9	0.92	5.5
10	0.92	4.9

The largest harvested yield was therefore obtained with three cuts a year, while the moment with five cuts gave the heaviest root weight. With an increased number of cuts a year both harvested yield and root weight tend to be reduced, and the decline of the latter with an increased number of cuts was particularly striking.

Roberts and Hunt in Wales have made a close study of the matter in question with the help of pot trials; the species used were perennial ryegrass and timothy. Cutting was carried out every thirtieth and every tenth day, in each instance with 1 in. and .5 in. stubble and also down to ground level. The effect of the different moments in regard to harvested yield, root weight and tillering was determined. (Table 14).

Table 14. Harvested yield, root weight and tillering with different methods of cutting.

	Cut every 30th day			Cut every 10th day		
	1" stubble	.5" stubble	cut at ground level	1" stubble	.5" stubble	cut at ground level
Perennial ryegrass						
Yield in grm. green mass...	89.37	36.55	8.80	6.11	4.73	2.06
Root mass in grm. dry matter	5.52	1.05	0.44	0.27	0.16	0.99
No. of tillers.....	117	81	44	89	47	21
Timothy						
Yield in grm. green mass...	15.12	5.82	1.41	1.10	0.72	0.14
Root mass in grm. dry matter	0.95	0.46	0.10	0.09	0.14	0.39
No. of tillers.....	40	20	9	12	7	3

Perennial ryegrass gave therefore a considerably larger yield than timothy and the former grass had also much stronger root development and tillering than the latter.

In both cases both the interval of time between the cuts and the stubble length had a very pronounced effect on the development of the plant, in that cutting every thirtieth day as regards

both harvested yield and root weight and also tillering gave considerably better results than cutting every tenth day.

The influence of stubble length was also very distinct, and the combination frequently repeated cutting - low stubble resulted in minimum development compared with a longer interval of time between the cuts and longer stubble.

An investigation on the influence of intensity of grazing on root development in grasses has been conducted in England by Jones. The investigation was carried out on a plot stand, and the results are given in Table 15.

Table 15. The influence of intensive cutting or grazing on root development. Grm. root mass per sample.

Sward	Lightly grazed	Hard grazed
Seeds mixture (3rd harvest year)	28.92±1.70 (cut)	19.46±1.77 (cut)
Very old permanent pasture	58.13±4.20	39.60±1.66
Perennial ryegrass (3rd harvest year)	32.98±1.35	26.68±1.65
Cocksfoot (3rd harvest year)	41.37±5.56	19.09±1.26
Red clover (3rd harvest year)	5.80±0.62	3.06±0.14

Hard grazing has therefore throughout entailed a weakening of the root system.

The reduction certainly varied for the different stands but the difference was very striking in all the cases investigated.

Finally it should be stated that Wallin in an investigation concerning the origin of rejected areas also established that hard and continuous grazing leads to a weakened

root system compared with rejected or incompletely grazed grass sward. (See Table 16).

Table 16.

Location	Soil	Dry weight of root mass in dm3	
		from rejected area (grm.)	from hard grazed area (grm.)
Beateberg	Sandy loam	32.91	8.16
"	Clay soil	8.67	8.07
Boda I a	Heath rich in mould	41.75	7.00
" I b	"	35.65	7.75
" 2 a	"	7.00	4.15
" 2 b	"	10.90	4.55
" 3 a	"	12.80	10.00
" 3 b	"	12.90	7.05

The results of these investigations agree very closely with those obtained by the author. Thus his series of pot trial with different numbers of cuts and different lengths of stubble are fully confirmed by the investigations conducted abroad. Also the corresponding plot trial series which comprised only differen lengths of stubble, and which as stated above did not give any statistically certain difference either as to harvested yield or root development, is supported by the investigation carried out by Roberts and Hunt in so far as the time between the cuts has proved to have greater significance for the development of grasses than length of the stubble.

Finally, as to the pot trial series and the plot trial series with different "grazing and resting periods", certainly non of the foreign investigations referred to are in complete agreement with them, but the results obtained by the author receive valuable support from the investigations conducted by Jones.

Literature.

1. BORG, J. Grunderna för betestillgångens reglerande genom betesmarkernas uppdelning i fållor. [Principles for regulating the amount of grass on pastures by the division of the pasture land into folds.] Nord. JordbrForskn. 8-9, A. 425-38. 1927.

2. ELOFSON, A., WALLIN, B., and NANNESON, L. Gårdskontrollen vid Blonbacka och Boda. [Controlled farming at Blonbacka and Boda.] Medd. Svensk. Betes- o. Vallfören. No.1. 87. [German summary, 84-7.] 1933.

3. GERNERT, W. B. Native grass behavior as affected by periodi clipping. J. Amer. Soc. Agron. 28. 477-56. 193

4. JONES, M. G. Grassland management and its influence on the sward. Pt.1. Factors influencing the growth of pasture plants. Emp. J. Exp. Agric. 1. 43-57. pls. 1933.

5. MUENZINGER, and RABO, F. von. Das Hohenheimer Weidesystem. [The Hohenheim pasture system.] Landw. Jb. 73. 139-68. 1931.

6. OLOFSSON, S. Undersökningar angående sambandet i utveckling av strå och rötter hos gräsen. Examensarbete. Manuskript. 1936. Investigations on the development of stems and roots in grasses. Examination study. Manuscript. 1936.

7. ROBERTS, R. A., HUNT, I. V. The effect of shoot cutting on the growth of root and shoot of perennial ryegrass (Lolium perenne L.) and of timothy (Phleum pratense L.). Welsh J. Agric. 12. 158-74. 1936.

8. SPRAGUE, H. B. Root development of perennial grasses and its relation to soil conditions. Soil Sci. 36. 189-209. 1933.

9. WALLIN, B. Ratorna i betesmarken. [Rejected areas in pasture.] Svenska Betes- o. Vallfören. Årsskr. 17. 137-49. [German summary, 149.] 1935.

LØVØ, P. J. Forsøk med ulike slåttetider for eng på forsøksgården Voll. [Trials with different times of cutting of meadows at Voll Experiment Station (Norway).] Meld. Stat. forsøksgård på Voll. 1937. pp.H9-51.

Translated from Norwegian. (R.P.J.)

Summary.

1. Results are reported from eight trials with different times of cutting of clover - timothy meadows at Voll Experiment Station during the years 1928 to 1936. Three times of cutting were tested: first time of cutting when timothy was coming into panicle, second time of cutting when timothy was beginning to flower, and third time of cutting a fortnight later.

2. The yield of hay increases considerably from the first to the second time of cutting. From the second to the third time of cutting there is also some, but a considerably smaller, increas

The increase from the first to the second time of cuttin is greatest in cold, rainy weather during the growing period and least in warm, dry weather. In the interval from the second to the third time of cutting on the other hand the increase has been greatest when the weather had been warm and dry earlier in the

growing period. The clover shows under otherwise similar conditions greater relative increase than timothy after emergence of panicle by this species. It is therefore probable that the increase between the times of cutting is greater the higher the clover content is in the meadow.

The time of cutting has an influence on the botanical composition and the size of yield of the meadow in the following year. The results indicate that the clover overwinters best after early cutting, while the timothy overwinters best after late cutting. As a rule early cutting brings about a slightly smaller yield in the following years when there is but little clover in the stand. In meadows rich in clover there is less danger of a reduction in yield the following year after early cutting.

After the first time of cutting a large aftermath crop was harvested. After the second time of cutting the aftermath crop was scarcely half as large as after the first time of cutting. After the third time of cutting in most years there was so little aftermath that in practice it would not pay to harvest it.

3. The coarse fodder's content of ash, fat and protein decreases with the degree of development of the grass. The content of these substances decreases therefore in the hay from the first to the third time of cutting, while it increases in the aftermath after the same times of cutting. The content of fibre and N-free

extractives on the contrary increases with the degree of development of the grass. The content of these substances in the hay is therefore lowest for the first time of cutting and highest for the third time of cutting, and in the aftermath it is highest after the first time of cutting and lowest after the third time of cutting.

4. The digestibility of the nutrient substances decreases with the degree of development of the grass. In the hay therefore the coefficients of digestibility are highest for the first time of cutting and lowest for the third time of cutting. In the aftermath this is reversed.

5. The percentage content of digestible nutriment im the hay is for all nutrient substances highest for the first time of cutting and lowest for the third time of cutting. In the aftermath this is reversed.

6. The fodder value and food unit concentration decreases from the first to the third time of cutting im the hay, while it increases after the same times of cutting in the aftermath. On the average of all the experimental years it takes from the first time of cutting 1.90 kg., from the second time of cutting 2.38 kg. and from the third time of cutting 2.63 kg. hay with 15 per cent moisture for one food unit. Of dry aftermath with 15 per cent moisture it takes 2.14 kg. after the first time of

cutting, 1.99 kg. after the second time of cutting and 1.84 kg. after the third time of cutting.

Calculations for aftermath are more uncertain than for hay because the coefficients of digestibility were not directly determined in some cases, but were stipulated after other investigations with other hypotheses.

7. The yield of food units per dekar in the hay crop alone is on the average of all the years greatest - and approximately equal - for the second and third times of cutting. The first time of cutting has yielded about fifty food units less.

In the aftermath the yield of food units is highest after the first time of cutting and lowest after the third time of cutting.

For hay and aftermath together the second time of cutt has given the highest yield of food units. Next comes the firs time of cutting, while the third time of cutting has given the lowest yield.

The amount of the yield per dekar of digestible protei and albumen is greatest for the first time of cutting and least for the third time of cutting. This holds good both for the hay alone and in a still higher degree for hay + aftermath.